

DEC STD 182-0 Engineering Documentation Acceptance Criteria

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ABSTRACT: This standard establishes the lettering requirements and related drafting practices and procedures necessary to produce engineering drawings and documentation of a quality that is acceptable for microfilm and subsequent reproduction.

APPLICABILITY: Mandatory for use by Digital personnel who are responsible for producing engineering drawings, documents, and subsequent ECOs.

STATUS: APPROVED 28-Feb-1990; use VTX SMC for current status.

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1 INTRODUCTION

1.1 PURPOSE

The purpose of this standard is to establish the lettering requirements and related drafting practices and procedures to be used in the preparation and revision of engineering drawings and documents. These requirements and practices are necessary to assure that the overall quality of engineering documentation is acceptable for microfilm and subsequent print reproduction, using the processes available within the corporation.

1.2 SCOPE

This standard updates the requirements for lettering on engineering drawings, formerly established in DEC STD 018 (now inactive), and supersedes that standard in its entirety. The scope of this standard is expanded to include related engineering drawing requirements, such as line quality, cleanliness and physical condition of the media. This increase in scope acknowledges that minimum requirements in each of these related areas, as well as lettering requirements, must be met to assure that the overall quality of a new, or revised, engineering drawing is acceptable for microfilm reproduction.

This standard includes requirements and practices for mechanically-typed engineering documents. It does not specify any unique requirements for computer-generated drawings and documents. Until such requirements are determined, computer-generated drawings and documents are subject to the appropriate engineering drawing acceptance criteria established in this standard, as required for microfilm and subsequent print reproduction.

1.3 RESPONSIBILITIES

1.3.1 Design/Drafting Groups

It is the responsibility of each Engineering Services Design/Drafting group that produces new engineering drawings, documents, and subsequent ECOs, to assure that those drawings and documents meet, as a part of the document release process, the requirements stated in this standard. This responsibility is shared by persons who draw, check, and handle the finished documentation.

1.3.2 Other Organizations

Organizations other than Design/Drafting groups, that prepare engineering documentation, are also responsible for meeting the requirements of this standard.

1.3.3 Site Design Library

The Design Library at each site is responsible for determining the acceptability of engineering documentation.

1.3.4 ECO Coordinators

It is the ECO Coordinators' responsibility to notify the responsible engineer if drawing restoration is required to process an ECO and determine whether the engineer wants to schedule drawing restoration concurrent with ECO activity or defer (see subhead 2.8).

1.3.5 Design Engineers

Design Engineers who rely upon the Engineering Services Design/Drafting groups to produce their drawings and documents are responsible for an awareness of the requirements of this standard.

2 REQUIREMENTS

2.1 GENERAL

All Digital engineering drawings and permanent engineering documents intended to be part of the Engineering Documentation System must be prepared for microfilm reproduction. The use of microfilm for reproduction requires that careful attention be given to the quality of the original engineering drawings during initial preparation and during subsequent revisions.

There are six general requirements that must be considered to assure that a drawing will be acceptable for microfilm reproduction. These are:

- a. Drawing size and format
- b. Character size
- c. Character style and spacing
- d. Line quality
- e. Physical condition of drawing media
- f. Cleanliness and condition of paper (or other media)

2.1.1 Site Drafting Evaluation

This standard provides specific criteria, in the form of graphic exhibits and dimensions, for drawing size and format, character size, and character style and spacing. Physical condition requirements are also specified. The drafting checker for each site will examine each engineering drawing or document, to be sure it meets these requirements, as part of the check procedures established in *DEC STD 010-0 Engineering Documentation Checking: General Requirements*.

Drawings determined to be unacceptable by the drafting checker will be returned to the responsible draftsperson, or to the organization that prepared the original document, for specified improvements.

The drafting checker will also attempt to evaluate compliance with line quality and cleanliness requirements. However, testing an engineering drawing for compliance with requirements such as line quality and cleanliness is highly subjective, without applying exhaustive inspection procedures. Therefore, the acceptance criteria for those qualities are in the form of required drafting practices and procedures that are to be implemented and checked by site Design/Drafting personnel.

2.1.2 Design Library Evaluation

Drawings whose line quality or cleanliness appears marginal to the drafting checker may be submitted to the site Design Library for evaluation. Such drawings may need to be test microfilmed by the Design Library to determine acceptability. If the test microfilm results are not satisfactory, such drawings will be returned to the site Design/Drafting group or originating organization, for specified improvements.

Site Design/Drafting groups are required to compare the time and expense of test microfilming with the cost of improving marginal drawings prior to submitting such drawings to the Design Library for evaluation.

2.2 DRAWING SIZE AND FORMAT REQUIREMENTS

All engineering drawings must be prepared on the appropriate standard size and format. Complete specifications are provided in *DEC STD 013 Standard Engineering Drawing Formats and Forms*.

2.3 CHARACTER SIZE

When the height of hand-drawn characters projected on a microfiche viewer is less than 1/8 inch (3 mm), they are difficult to read. The requirement is that characters be drawn large enough so that when the microfiched drawing is projected, they will not be appreciably smaller than 1/8 inch.

Based in the 11 x 14 inch image dimensions of the portable microfiche viewer used by field service engineers, the net reduction and minimum required character height for each size engineering drawing is specified in Table 1. E and J sizes are not usable for microfilm in their original form, and must be reduced either photographically or manually (at additional expense) as part of the microreproduction process.

Table 1: Minimum Character Height Requirements

Parameters ¹	A (A4)	B (A3)	C (A2)	D (A1)
Drawing Size (in.)	8-1/2 x 11	11 x 17	17 x 22	22 x 34
Projected Image Size (in.)	8-1/2 x 11	11 x 14	11 x 14	11 x 14
Net Reduction Ratio	1 : 1	1 : 1	1.5 : 1	2 : 1
Minimum Character Height	1/8 in. (3 mm)	1/8 in. (3 mm)	3/16 in. (5 mm)	3/16 in. (5 mm)

¹Refer to Tables 2 and 3 for specific requirements for each information category.

2.3.1 Exceptions For Certain Hand-Drawn Characters

The size of some characters on circuit schematics is presently restricted to 1/8 inch (3 mm), where limited by logic symbology.

2.3.2 Exceptions For Certain Machine-Drawn Characters

The PDF Character Set (generated from the Parts Data File) is used to produce machine-drawn characters on X-Y plotters, such as Calcomp and Varian. Character height is .065 inch, unless otherwise defined by programming algorithms. For example, character height is reduced 80%, to .052 inch, to place reference designators within the outlines of small components shown on unit assembly drawings, such as diodes and resistors. When labeling larger components, such as integrated circuits, more space is available and the character height will be doubled to 0.130 inch.

Table 2 lists the required character height (in inches) for each particular category of information that appears on an engineering drawing. Table 3 lists the character height requirements (in both millimeters and equivalent inches) for metric unit engineering drawing formats.

Table 2: Character Height Requirements For US Customary Unit Engineering Drawings

Information Category	Character Height for Each Drawing Size (inches)				
	A	B	C	D	E & Over
CHARACTERS IN BODY OF DRAWING	5/32	5/32	3/16	3/16 ²	3/16 ¹
CIRCUIT SCHEMATIC Where limited by logic symbology	1/8	1/8	1/8 ¹	1/8 ¹	-
TITLE ¹	3/16	3/16	3/16	1/4	1/4
DOCUMENT NUMBER ¹ Size, Code, Number, Rev					
In Title Block	5/32	5/32	3/16	3/16	3/16
In Supplementary Block	1/8	5/32	3/16	3/16	3/16
PARTS LIST	-	1/8 ¹	-	-	-
OTHER TITLE BLOCK ¹ INFORMATION					
Material, Finish, Next Higher Doc	1/8	1/8	3/16	3/16	3/16
Scale & Sheet Number ¹	1/8	1/8	1/8	1/8	1/8
FRACTIONS & TOLERANCES	5/32	5/32	3/16	3/16	3/16
X and Y COORDINATES ¹	3/8	3/8	3/8	1/2	1/2
SURFACE QUALITY (when required)	3/32	3/32	1/8	1/8	1/8
COPYRIGHT DATE	1/8	1/8	1/8	1/8	1/8
ITEM NUMBER	1/4	1/4	1/4	1/4	1/4

¹Indicates where use of lettering guide or typing is required.²Lettering guide required for assembly drawings only.

Table 3: Character Height Requirements For Metric Unit Engineering Drawings

Information Category	Character Height for Each Drawing Size				
	millimeters (inches)				
	A4	A3	A2	A1	A0 & Over
CHARACTERS IN BODY OF DRAWING	4 (5/32)	4 (5/32)	5 (3/16)	5 (3/16) ²	5 (3/16) ¹
CIRCUIT SCHEMATIC Where limited by logic symbology	3 (1/8)	3 (1/8)	3 (1/8) ¹	3 (1/8) ¹	-
TITLE ¹	5 (3/16)	5 (3/16)	5 (3/16)	6 (1/4)	6 (1/4)
DOCUMENT NUMBER ¹					
Size, Code, Number, Rev In Title Block	4 (5/32)	4 (5/32)	5 (3/16)	5 (3/16)	5 (3/16)
In Supplementary Block	3 (1/8)	4 (5/32)	5 (3/16)	5 (3/16)	5 (3/16)
PARTS LIST	-	5 (1/8) ¹	-	-	-
OTHER TITLE BLOCK ¹ INFORMATION					
Material, Finish, Next Higher Doc	3 (1/8)	3 (1/8)	5 (3/16)	5 (3/16)	5 (3/16)
Scale & Sheet Number ¹	3 (1/8)	3 (1/8)	3 (1/8)	3 (1/8)	3 (1/8)
FRACTIONS & TOLERANCES	4 (5/32)	4 (5/32)	5 (3/16)	5 (3/16)	5 (3/16)
X and Y COORDINATES ¹	10 (3/8)	10 (3/8)	10 (3/8)	12 (1/2)	12 (1/2)
SURFACE QUALITY	3 (3/32)	3 (3/32)	3 (1/8)	3 (1/8)	3 (1/8)
COPYRIGHT DATE	3 (1/8)	3 (1/8)	3 (1/8)	3 (1/8)	3 (1/8)
ITEM NUMBER	6 (1/4)	6 (1/4)	6 (1/4)	6 (1/4)	6 (1/4)

¹Indicates where use of lettering guide or typing is required.

²Lettering guide required for assembly drawings only.

A4 = 210 x 297 mm (approx A size)
A3 = 297 x 420 mm (approx B size)
A2 = 420 x 594 mm (approx C size)
A1 = 594 x 841 mm (approx D size)
A0 = 841 x 1189 mm (approx E size)

Table 4 lists part numbers of commercially-available lettering guides for each required lettering size.

Table 4: Lettering Guide Part Numbers

Lettering Guide	Part Number ¹
1/8 inch	See Note
5/32, 3/16, and 1/4 inch	R-965
3/8 inch	R-966
1/2 inch	R-967
3 mm	See Note
4 mm, 5 mm, and 6 mm	R-2965
10 mm	R-2967
12 mm	R-2966
Mathematical (includes Greek Letters)	R-17
Lettering Aid for spacing between lines of characters	R-925

¹Part numbers relate to lettering guides manufactured by Berol RapiDesign, Danbury, CT 06810. Any commercially-available lettering guides that provide equivalent character styles are acceptable.

NOTE

Use the 1/8-inch Gothic lettering guide that is currently available, such as Timesaver Lettering Guide, No. 260-V, or equivalent.

2.4 CHARACTER STYLE AND SPACING

Elements that contribute to legibility of text information on an engineering drawing are character style (shape), composition (spacing between characters), uniform density of lines, positioning, and the spacing between lines of characters. Requirements for each of these elements, as they pertain to hand-drawn characters, are specified in this section.

2.4.1 Style

The style of lettering for hand-drawn characters is based on Microfont, a style designed by the National Micrographics Association's Drafting Standards Committee, for the general use of industries that produce engineering drawings intended for microreproduction. Examples of the hand-drawn letter styles are shown in Figure 1.

The style for hand-drawn alphabetic characters and numerals (Figure 1A) replaces previously specified hand-drawn lettering styles such as single-stroke, commercial Gothic. The major difference is that alphabetic characters such as "C", "G", and "S", and numerals such as "3", "4", "5", and "6" are drawn with less closure than corresponding Gothic characters and numerals. As a result, when manually-lettered drawings are microreproduced, these characters and numerals are less likely to fill in and look like a "0", "8", or "9".

- a. Special Characters and Symbols - The mathematical symbols and Greek alphabet characters most often used on engineering drawings are shown in Figure 1. This standard does not prohibit the use of other special characters or symbols, not shown, that may be required. Draftsperson need to be particularly careful when special characters or symbols not shown in Figure 1 or included on commercially-available lettering guides are required.
- b. Lower Case Letters - Lower case letters are not normally used in engineering drawings because they essentially present a second (and smaller) character size to the reader. They can be used for certain abbreviations and units of measurement, where required by DEC STD 015. Lower case letters may also be required to accurately describe certain products, such as ASCII terminals. Figure 2 shows the lettering style requirements for special lower-case lettering.

Figure 1: Hand Lettering Style Examples

A B C D E F G H I J K L M N O P Q R
S T U V W X Y Z 1 2 3 4 5 6 7 8 9 0

A. DIGITAL LETTER STYLE FOR HAND-DRAWN
ALPHABETIC CHARACTERS AND NUMERALS

. , : ; = ÷ + - " % ' < >
@ & * ? # () [] ° ! \$ % / _

B. DIGITAL LETTER STYLE FOR HAND-DRAWN
ASCII-COMPATIBLE CHARACTERS

μ α √ σ δ Σ γ π β θ ω Ω ∴ ∥
∠ ∞ Δ ≈ ~ Ø

C. RECOMMENDED STYLE FOR HAND-DRAWN
GREEK LETTERS AND MATHEMATICAL SYMBOLS

Figure 2: Lower Case Letter Style Example To Be Used Only for Special Requirements

a b c d e f g h
i j k l m n o p q
r s t u v w x y z

2.4.2 Composition

For best legibility, characters in words are not usually equally spaced. Instead, they are arranged so that the areas of space between characters are approximately equal. As a result, the spacing between characters appears to be equal. The general rule to follow is that characters with straight sides should be spaced farther apart than characters with curved sides. An imaginary "I" between words will provide sufficient space so that words will not run together. Specific rules for composition cannot be applied; each draftsman must use good judgment.

2.4.3 Uniform Density

Another factor that affects the reproducibility of a drawing is the uniformity of each character. There is a tendency to produce heavier lines on downward strokes when hand lettering. The ability to produce hand-drawn letters of uniform density is a drafting skill acquired by practice. Any disparity in density on an original drawing will be even more evident on subsequent microreproductions.

2.4.4 Orientation of Characters

Orient all characters, dimensions, fractions (when used), and notes so that they can be read from the bottom of the drawing.

2.4.5 Spacing Between Lines of Characters

Generally, the recommended space between lines of characters is from one-half the character height to the full height of the character. Table 5 lists the minimum space required between lines of characters.

Table 5: Minimum Space Required Between Lines

DRAWING LOCATION	A (A4) Size		B, C, D (A3, A2, A1) Sizes		E (A0) Size or Larger	
	mm	(in)	mm	(in)	mm	(in)
Body of Drawing	2.4	(3/32)	3.0	(1/8)	3.0	(1/8)
Revision Column	1.5	(1/16)	1.5	(1/16)	1.5	(1/16)
Note Column	2.4	(3/32)	2.4	(3/32)	3.0	(1/8)

A commercially-available lettering aid (listed in Table 4) may be used to maintain equal distance between lines of characters.

2.5 LINE QUALITY

Line quality is a key factor in producing engineering drawings acceptable for microfilm, as well as other reproduction processes. Obviously, lines drawn too lightly may not appear when reproduced. For microfilm reproduction, heavy line work must also be avoided. A heavy deposit of graphite reflects light. Instead of reproducing as a heavy line, only a hint of the line appears. Lines of various density also cause problems when a drawing is reproduced or microfilmed, because the uniform settings used in the reproduction processes will produce unsatisfactory results.

2.5.1 Graphite Lead Pencil Lines

The quality of hand-drawn, pencil line work is determined by several variables, such as pencil hardness and sharpness, pressure applied, and paper quality. To assure consistent line quality, use the following guidelines. The selection of the grade of pencil or lead, under a given set of conditions, is determined by a number of factors, such as:

- Quality and texture of the drawing medium.
- Environmental conditions, such as humidity, and their effect on the drawing medium.
- Type of drafting work being done.
- Method of reproduction.
- Draftsperson's personal preference.

For hand-drawn pencil drawings to be microreproduced, consistent line quality is the primary concern. Each drafts person should:

1. Select a lead hardness grade that will enable them to assure consistent line quality. Lines made with softer leads increase the risk of smudging. Lines made with harder leads are less erasable, which increases the risk of ghosting, especially when microfilmed.
2. Apply constant pressure to maintain a uniform line density. Line width should not be less than .010 inch; this is the minimum width that can be microfilmed at a 30X reduction ratio and remain legible. Maximum line width should not exceed .020 inch.
3. Avoid mixing ink, light pencil, light graphite, or plastic lead on the same drawing if uniform line density cannot be maintained. Otherwise, the line densities may be so different that a usable microfilm reproduction cannot be made.

2.5.2 Plastic Lead Pencil Lines

Use a special composition plastic drawing lead when drawing on mylar or polyester drawing film. Eagle Turquoise Filmograph (5375), degree E2, is a typical plastic drawing lead that provides acceptable line quality.

2.5.3 Paper Quality

The use of standard engineering drawing formats specified by DEC STD 013 is required. These formats are pre-printed on high-quality vellum (Bruning #40-105).

2.6 CLEANLINESS AND SURFACE CONDITION OF MEDIA

The cleanliness and surface condition of the paper (or other material) used to produce an engineering drawing is a factor in providing a quality drawing that is acceptable for microfilm reproduction. The following good drafting practices are required:

- a. Paper has a surface porosity and tooth which affect the paper's ability to hold a line and not smudge. Avoid use of eraser powder or pounce which will clog the pores and reduce the paper's ability to hold a line in that area.
- b. Be careful when erasing lines from either vellum or polyester. Erasing can damage the finish and reduce the ability of the media to hold a line. Use a soft pencil eraser on paper. If the paper has been grooved by the line, it may be restored by rubbing the reverse side with a burnishing tool or with the back of the thumbnail. (Sometimes the tooth can be restored by passing a hand eraser over the buffed area.)
- c. Electrical erasers can damage vellum and polyester by producing too much heat. Use such erasers lightly. Use a heat sink backing (brass, copper or aluminum) to dissipate the heat, if an extensive amount of erasing is required.

NOTE

Often, an erased area is much cleaner than the rest of the drawing. When a change is made in the erased area, the contrast between line and background is different from the rest of the drawing. This condition can be a problem in microfilm reproduction.

- d. To prevent a drawing from being smeared by soil build-up, during initial preparation or a revision, sprinkle the paper lightly with pulverized gum eraser particles (commercially available). These will pick up loose graphite and also keep drafting tools clean as you work.

2.7 PHYSICAL CONDITION OF MEDIA

The physical condition of a drawing is important for acceptable microfilm quality. For that reason:

- a. Store and transport drawings flat, not folded or rolled (J-size excepted). Drawings that have been tightly rolled will not lay flat on the camera bed or in the storage cabinets. Drawings that have been folded with creases through engineering data will not be accepted (except as indicated in paragraph 2.10.3.b).
- b. Minor tears must be mended with transparent mending tape, on the reverse side of the drawing, before the drawing is submitted to site Document Control for microfilming.
- c. Large tears that pass through engineering data on the drawing may not be repairable; a washoff will be required for microfilming.
- d. If a manually-drawn original is being subjected to considerable physical handling (or will be), have a washoff made (and destroy the original) to provide a more rugged drawing that is less likely to be damaged or smudged by handling.

2.8 SPECIAL PROCEDURES FOR ECOS

The site Design Library and the ECO coordinator will evaluate each document prior to processing an ECO that affects the document. If restoration is needed to meet the requirements of this standard, the ECO coordinator will notify the responsible engineer. The document must be restored prior to releasing the completed ECO to the Design Library.

In addition to documents that have been subjected to physical handling, all overlays and sepias must be replaced prior to the ECOs release to the Design Library. Changes to typewritten documents must be made in the same density as the original typed data.

2.9 RECREATED SPECIAL REVISION DRAWINGS

The acceptance criteria established for new and revised original engineering drawings shall also apply to reproducible recreations of master drawings.

If the current revision of the original drawing is requested, make a washoff of the original drawing.

NOTE

Sepia drawings are not acceptable for microfilming.

2.10 MECHANICALLY - TYPED DOCUMENTS

Several kinds of engineering documents, such as specifications, tables of contents, and parts lists are typed on pre-printed engineering drawing formats. Word processors are used to produce documents such as DEC standards. High-speed line printers may be used to output automated parts lists. As engineering documents, the quality of these documents must be acceptable for microfilm and subsequent reproduction. Therefore, the acceptance criteria specified in previous paragraphs for hand-drawn documents, also apply to mechanically-typed documents.

The following paragraphs provide recommended practices and procedures to use in the production of mechanically-typed engineering documents.

2.10.1 Typewriter Ribbon Selection

Experimentation with various ribbons is recommended since some are subject to smudging, while others contain oils that penetrate the drafting medium and make erasures difficult. Some erasures are not visually objectionable but ghost images appear on the microfilm. This effect occurs because the film sees things which the eye does not. Manufacturers of drawing media usually offer recommended types or brands of typewriter ribbons for use with their materials.

It is essential to be sure that the ribbons used are in good condition or the letters which are formed may not be uniform in density and, consequently, will not read satisfactorily. Machines used for typing should be kept clean so that the letters are uniform in density. Typing should be used wherever practical, because of the advantages of economy, speed, and uniformity of quality. Figure 3 shows typical effects resulting from the use of improper or poor ribbons.

Five points should be considered when selecting a typewriter ribbon:

- a. It should leave a clear, sharp impression.
- b. It should not smudge.
- c. It should photograph well and should be opaque when back-lighting is used or contact copies are made.
- d. It should not penetrate the drafting media and should erase easily and completely.
- e. It should wear well and have good aging characteristics

Figure 3: Results of Using Poor or Improper Typewriter Ribbons

THIS IS A TYPICAL EXAMPLE OF
TYPING WITH A RIBBON WHICH
HAS TOO MUCH INK.

THIS IS TYPICAL OF TYPING
WITH A WORN RIBBON

IMPROPER ERASING OF TYPING
WHICH WAS DONE WITH A RIBBON
CONTAINING TOO MUCH INK LEADS
TO GHOST IMAGES.

CARBON RIBBON MUST BE HANDLED
PROPERLY TO AVOID ~~SMEARING~~

2.10.2 Typewriter Font Selection

The preferred type style is Courier 72 (10 Pitch). This type style allows 10 character spaces per inch. The capital letters are 1/8-inch high and the type style is a square-serif design that is easy to read and less likely to break-up when microfilmed than other type styles with finer line weight.

Other 10-pitch type styles will produce engineering documents that are acceptable for microfilming, if the Courier 72 is not available. Avoid using 12-pitch type styles and do not use script or italic type styles.

2.10.3 Recommended Typing Practices

In addition to the usual good typing practices, there are some practical suggestions that apply to typing engineering documents.

- a. Type an initial sample sheet that includes the entire font. This can be used for comparison as typing progresses to determine when the ribbon should be changed or other action should be taken to improve quality.
- b. If it is necessary to fold a preprinted format so that it will fit into the carriage, crease the format where no engineering data will be typed.

- c. Erase with a plastic or art gum eraser; never use Snopake, Liquid Paper, or correction tape on engineering drawings.
- d. Set the impression adjustment on the typewriter so that it will not emboss the paper surface.

APPENDIX A REFERENCED DOCUMENTS

A.1 EL-Class Digital Documents

EL-Class Number	Document Title
EL-00010-00	<i>DEC STD 010-0 Engineering Documentation Checking: General Requirements</i>
EL-00012-01	<i>DEC STD 012-1 Unified Numbering Code: Document Identification Conventions</i>
EL-00013-00	<i>DEC STD 013-0 Standard Engineering Drawing Formats and Forms - Introduction</i>
EL-00015-00	<i>DEC STD 015-0 Abbreviations and Units of Measurement</i>
EL-00100-00	<i>DEC STD 100-0 Policy and Requirements for the Product Change Process</i>
EL-00114-01	<i>DEC STD 114-1 Engineering Drawing Requirements - Dimensioning and Tolerancing for Engineering Drawings</i>
EL-00140-07	<i>DEC STD 140-7 Engineering-Supervised Build (ESB) Release Requirements for Printed-Wiring Boards, Modules, and Backplanes</i>
EL-SM182-00	<i>Design Drafting Process Standards and Related Documents</i>

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